ASCI Academic Strategic Alliances Program
Pre-Proposal Conference

December 5-6, 1996

David Nowak
LLNL ASCI Program Leader
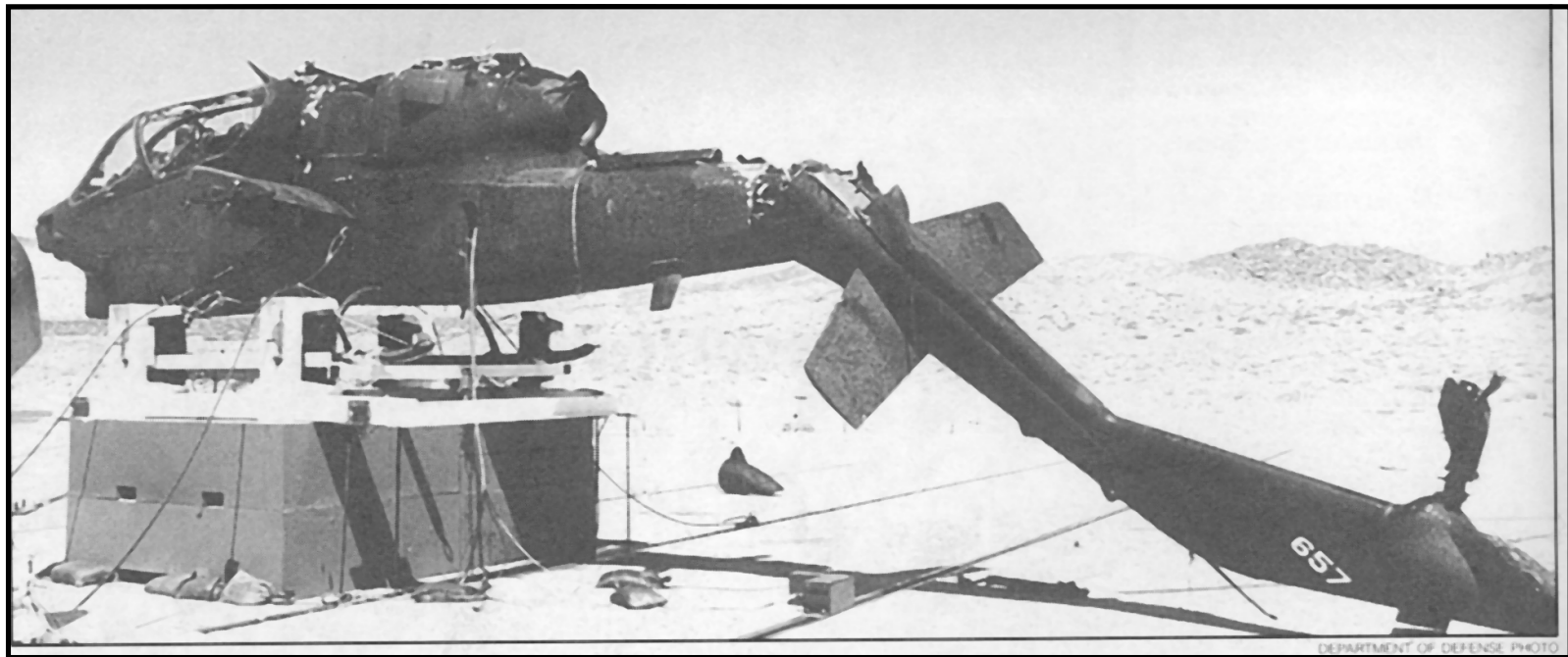**Lawrence Livermore National Laboratory**

Our research interests in computational physics spans several areas

- Turbulence modeling

- Transport modeling

- Computational fluid dynamics

- Computational mechanics

We must address probems at a wide range of scales: energy, size, time, density, etc.

High energy density is an essential figure of merit for stockpile stewardship

Opacity

Compressible turbulence

EOS

Radiative transport

Pure hydro

Radiation-driven hydro

Stewardship requires modeling complex coupled phenomena and validating those simulations against experimental data. These are examples of high energy density issues relevant to this mission.

41117

Engineering applications require research in damage mechanisms and failure mechanics

In order for simulations to be useful, they must model the entire problem — the whole range of physics and scales.

# Reality shoots holes in simulation in head-to-head trials

- **DoD's Joint Live-Fire Testing program tested the effect of a shell hitting moving helicopter blades.**

- **Computer models simulated the test**

- **On a scale of 1 to 10, the models scored:**
  - **A 2 in predicting the loss of a helicopter**
  - **A 3 in predicting the destruction of the helicopter blade**
  - **A 7 in predicting how the shell would penetrate the blade**

> **The helicopter simualtion modeled one piece of the problem correctly (penetration of the blade by a shell). To be useful, the model must incorporate the entire system, all of its components, their interactions, and the various phenomena associated with their operation.**

The tests showed that computer models are far from being able to accurately mirror real life.

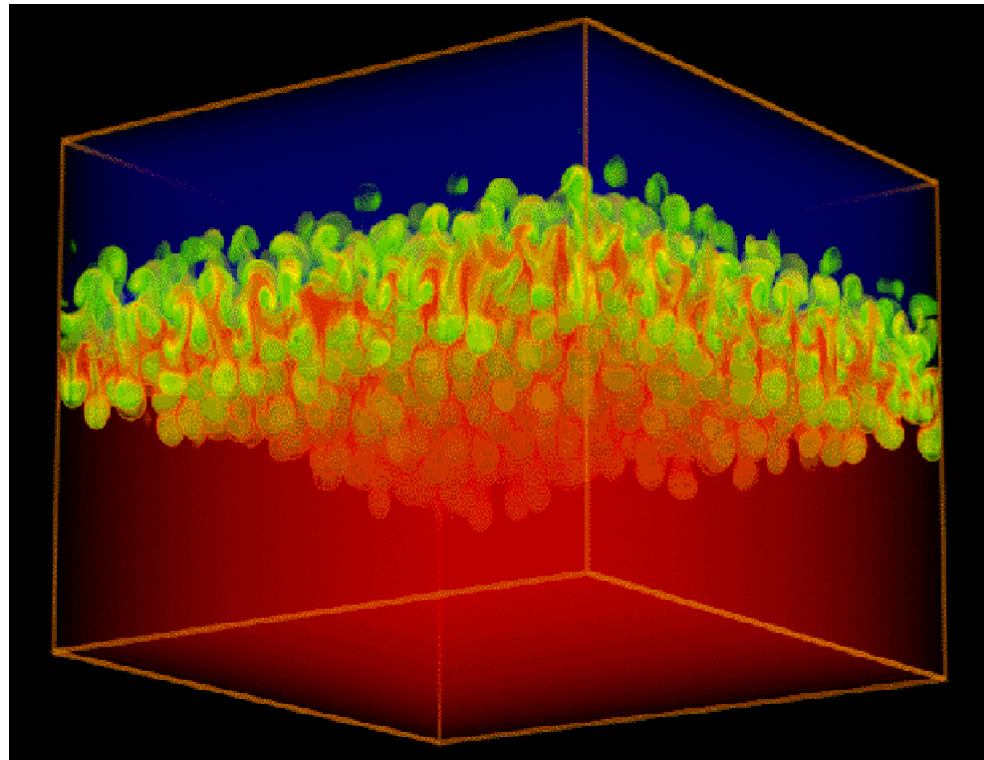# Opacity plays a central role in transport
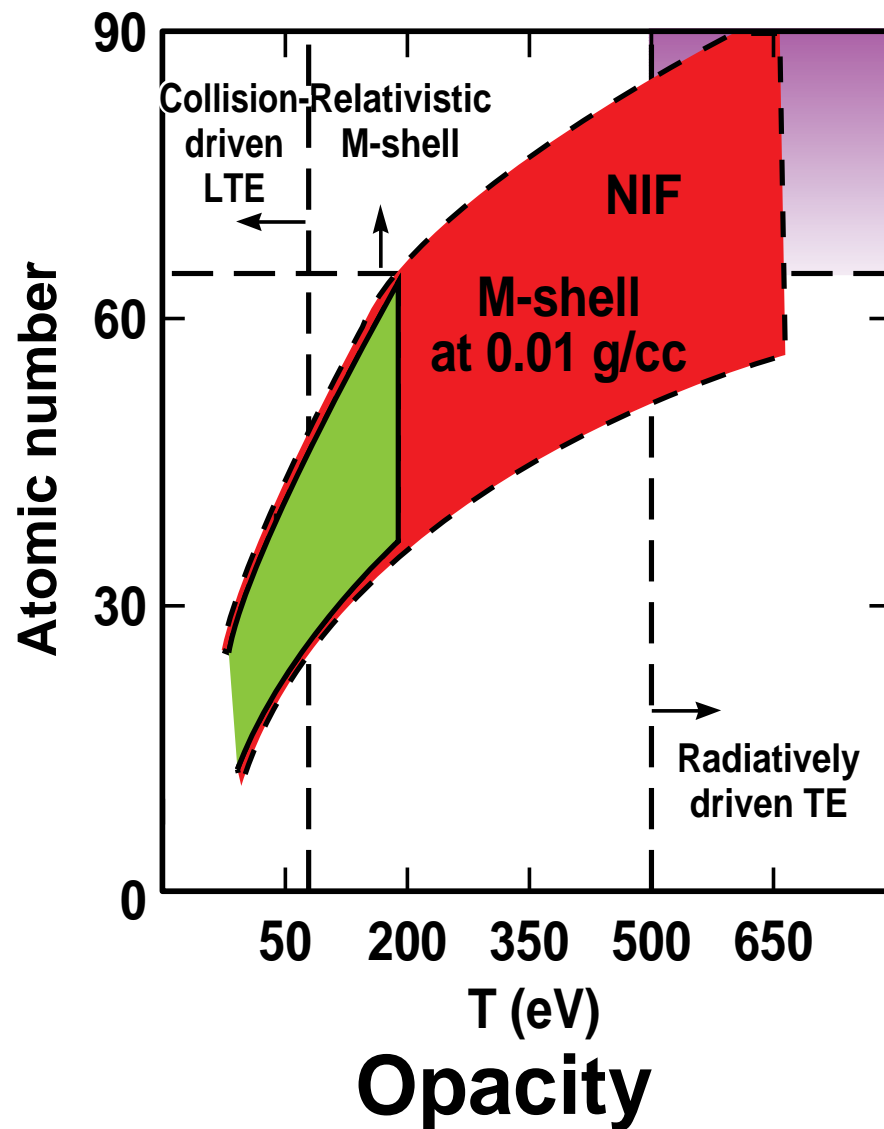
Opacity

A key to our approach is to validate our simulations against data gathered in underground tests in the past, and in aboveground experimental facilities, like NIF, in the future.
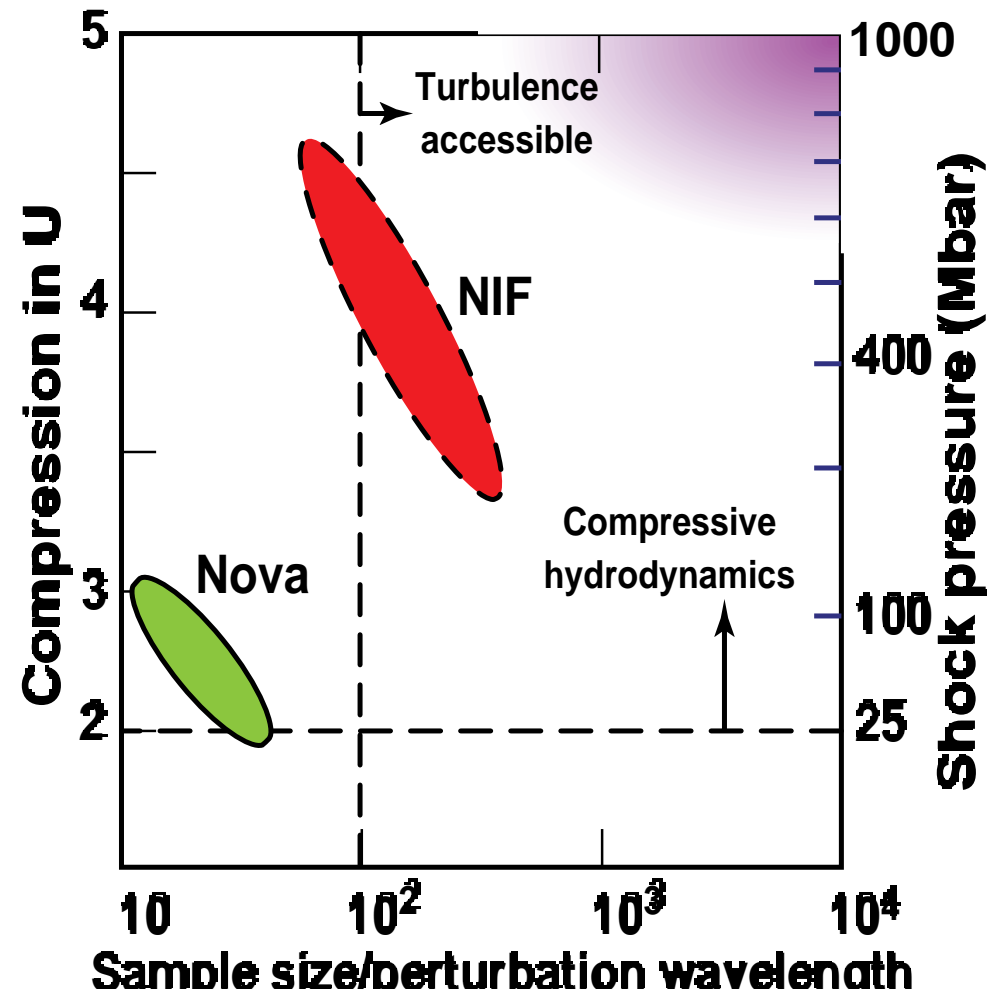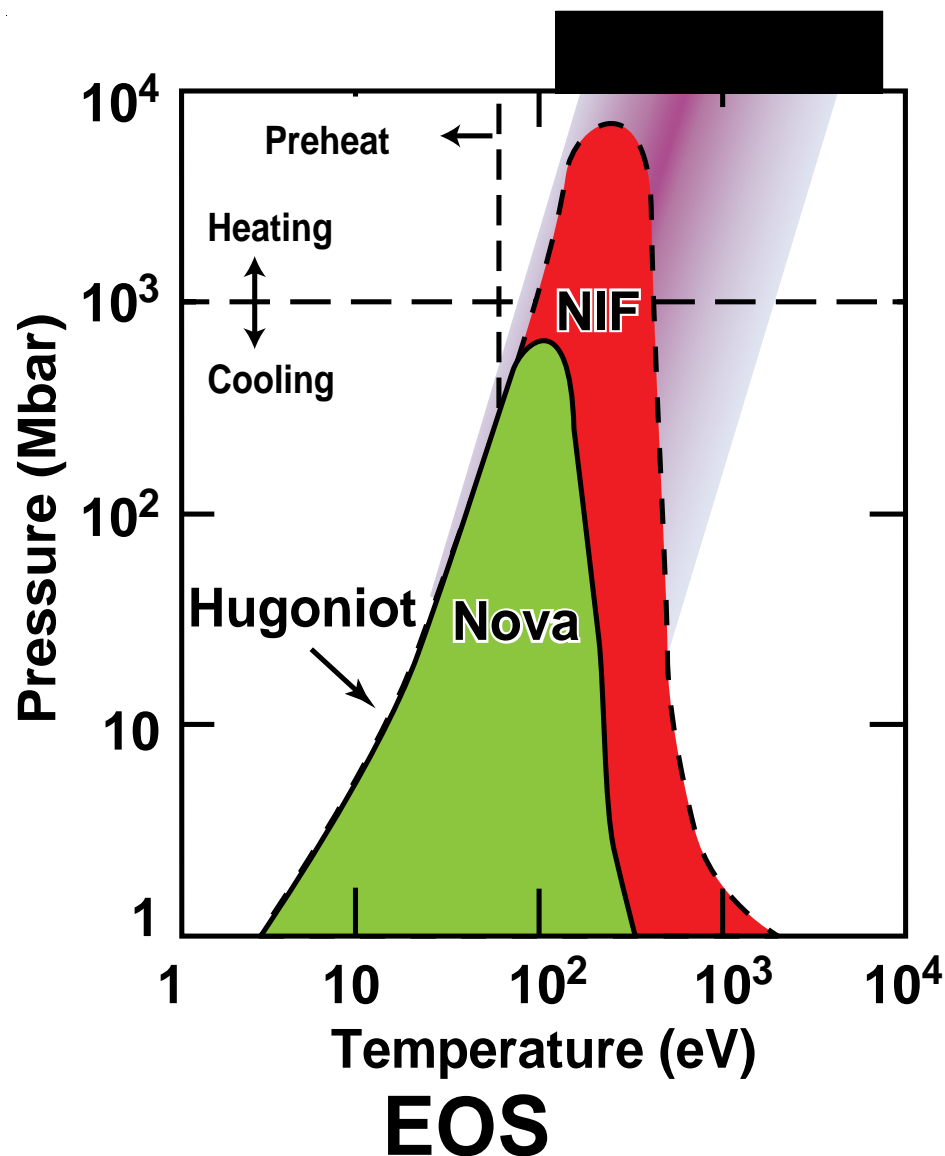

Compressible Turbulence
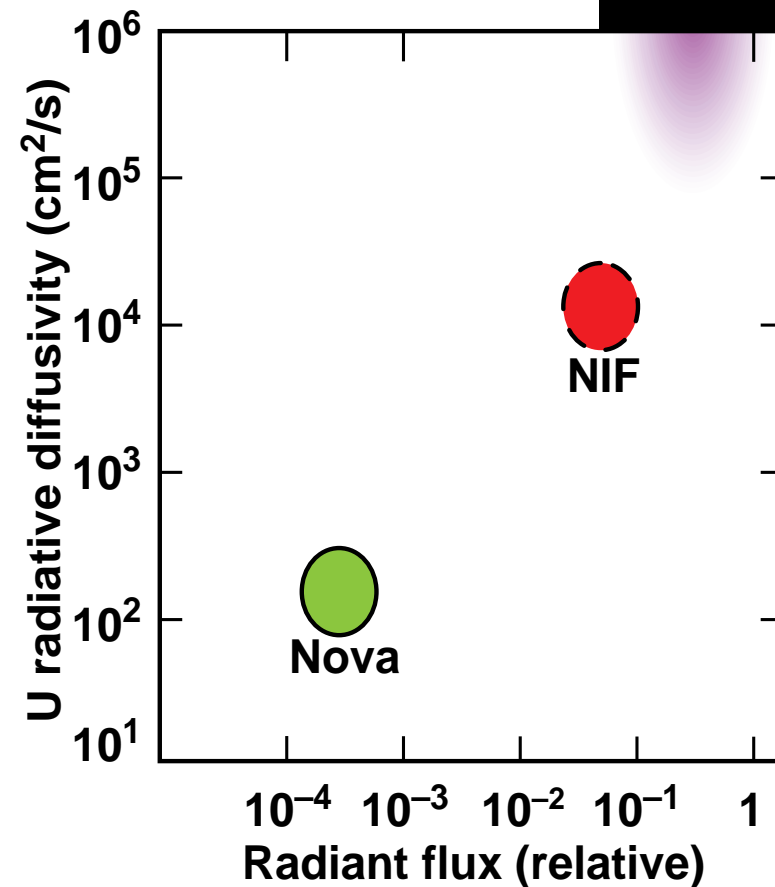
Turbulence modeling is an ongoing activity

Even this relatively simple 3D model generated a terabyte of data. One of our significant challenges is to visualize and understand simulations of this size.

Accurate physical data provides a foundation for accurate numerical simulations

EOS

Radiative transport

ASCI-97-012.11
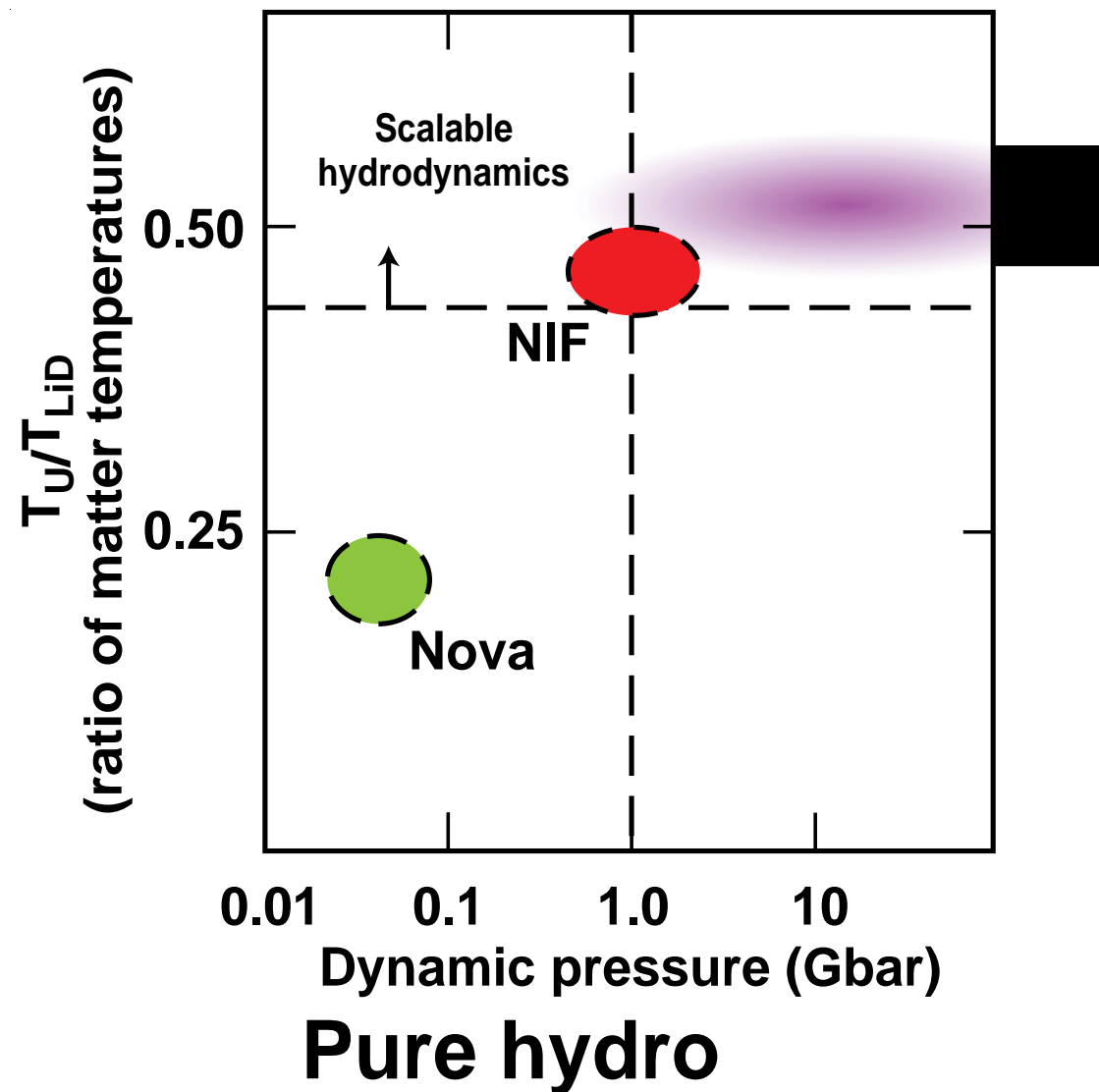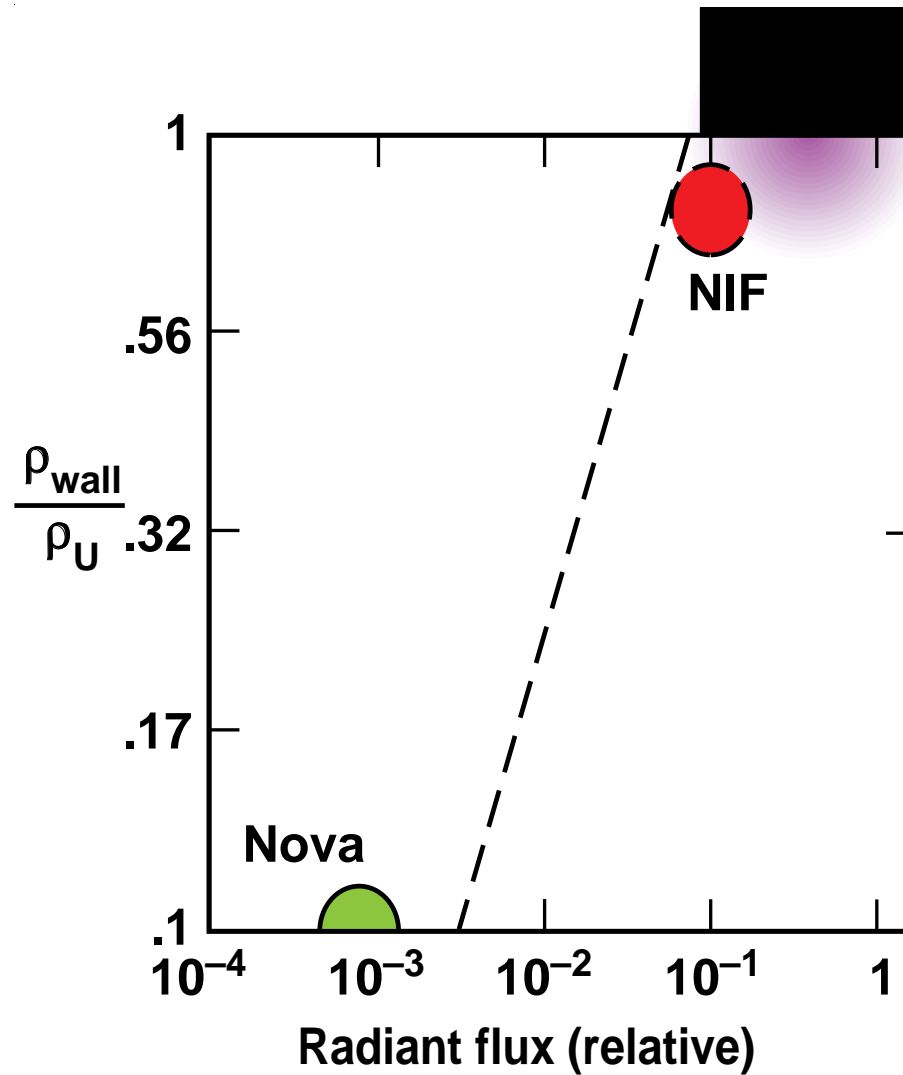
Radiation-driven hydro

Experimental data will benchmark advanced computational facilities

High growth factor implosion experiments provide a critical test of 3D codes

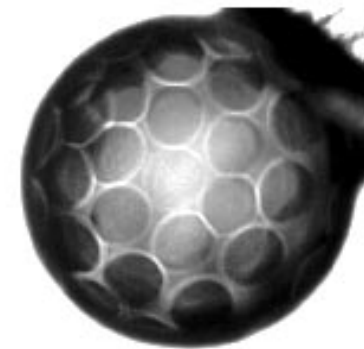**Temperature contours (keV) at bang time for an unperturbed capsule**
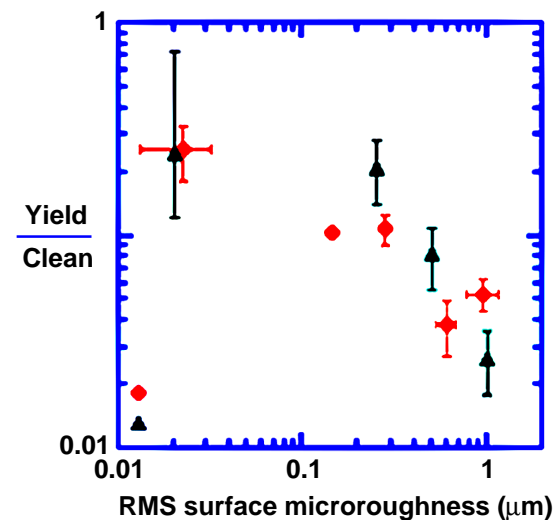
Random drive asymmetry
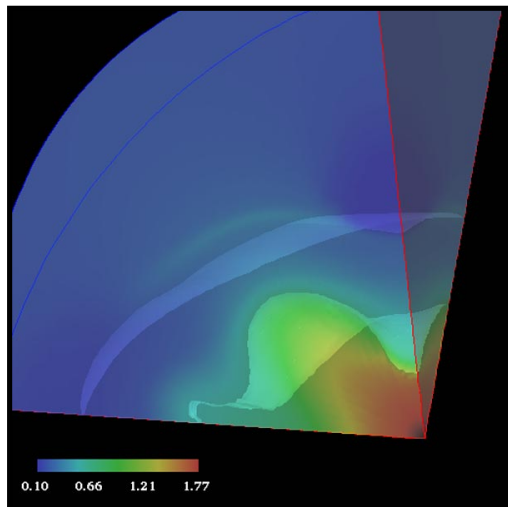
Random drive asymmetry + low modes

Pre-imposed roughness

| 0.10 | 0.66 | 1.21 | 1.77 |
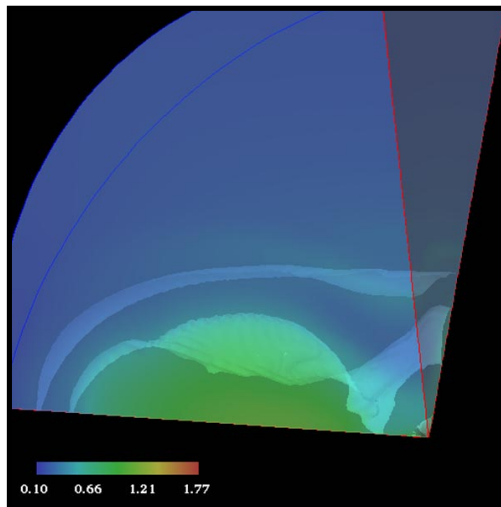
Coupling between low mode shell perturbations and drive asymmetry degrade Nova capsule performance
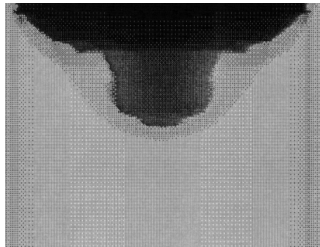

Yield / Clean
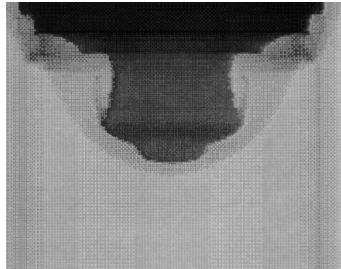
RMS surface microroughness (μm)

Our goal is to compare ASCI simulations to existing experimental data
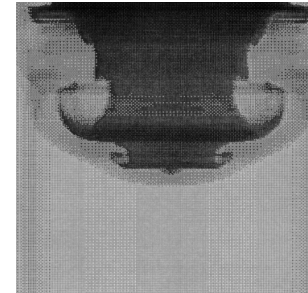
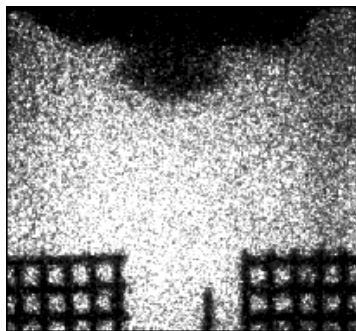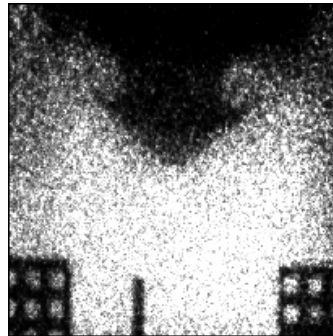- **Simulated radiographs from CALE calculation**
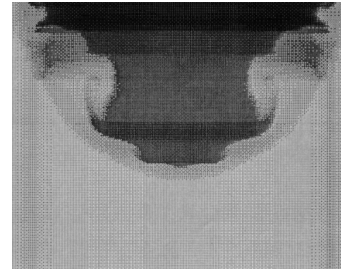
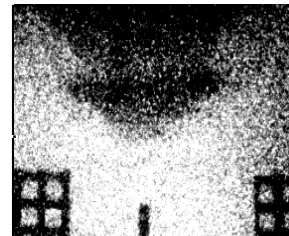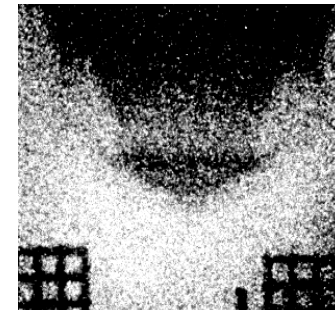| **10.5 ns** | **15.5 ns** | **19.5 ns** | **25.5 ns** |

Data radiographs

| **10.6 ns** | **14.8 ns** | **19.7 ns** | **21.9 ns** |

ASCI Alliance Strategy

- **Risk reduction**
  - Algorithms tested over a broad range of phase space
  - Many applications tested over a broad range of phase space
  - Taps a broad range of computer science expertise

- **Validation**
  - Best form of external peer review